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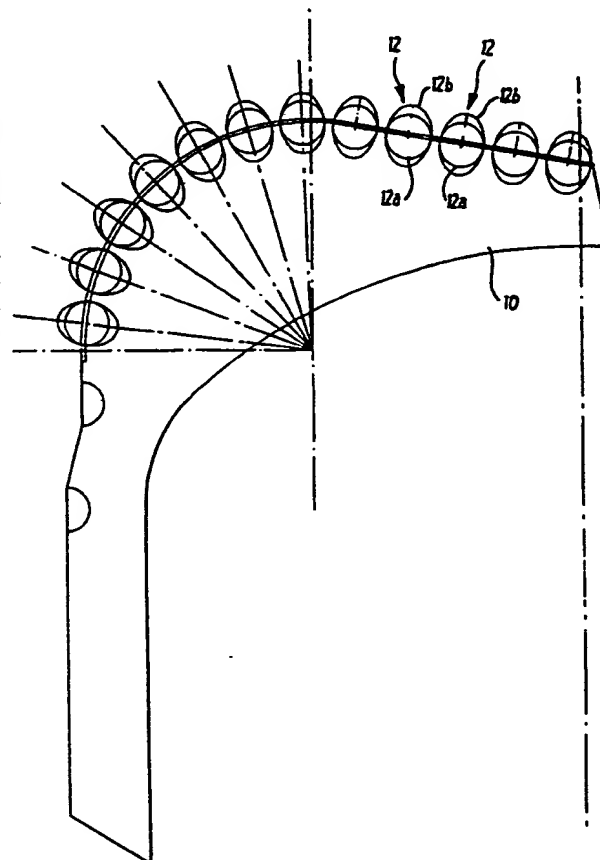
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/GB92/00321 (22) International Filing Date: 21 February 1992 (21.02.92) (30) Priority data: 9103828.1 23 February 1991 (23.02.91) GB (71) Applicant (for all designated States except US): BRIT BIT LIMITED [GB/GB]; Units 2 & 3, Logman Centre, Greenbank Crescent, East Tullos, Aberdeen AB1 4BG (GB). (72) Inventors; and (75) Inventors/Applicants (for US only) : SIMPSON, Neil, Andrew, Abercrombie [GB/GB]; Burn of Daff Farm, Downies, Portlethen, Aberdeen AB1 4QX (GB). BAIN, James [GB/GB]; 2 Cairngrassie Drive, Portlethen, Aberdeen AB1 4TY (GB).		(74) Agent: PACITTI, Pierpaolo, A., M., E.; Murgitroyd and Company, Mitchell House, 333 Bath Street, Glasgow G2 4ER (GB). (81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB, GB (European patent), GR (European patent), IT (European patent), LU (European patent), MC (European patent), NL (European patent), NO, SE (European patent), US. Published <i>With international search report.</i>
(54) Title: IMPROVEMENTS RELATING TO DRILL BITS (57) Abstract A polycrystalline diamond cutter (PDC) (12) is described which is elliptical or oval, rather than circular, in shape, having a major axis which extends outwardly from the drill bit body (10) when in use. The elliptical or oval shape of the PDC provides advantages in terms of the rate of development of the wear flat, the weight on bit requirement, and the useful cutting area and cooling characteristics of the PDC in comparison with circular configurations. The PDC's may be post mounted. Drill bits incorporating the PDC and methods of forming suitable bit bodies and mounting posts are also described.		



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1 "Improvements Relating to Drill Bits"

2

3 The present invention relates to drill bits for use in
4 oil drilling or the like and is particularly concerned
5 with improvements in polycrystalline diamond cutting
6 products for use in such drill bits.

7

8 Polycrystalline Diamond Compacts (PDC's), or cutters,
9 generally comprise a polycrystalline diamond layer
10 affixed to a tungsten carbide substrate, a plurality of
11 PDC's being mounted in a bit body to produce a
12 functional drill bit. Conventional PDC's are circular,
13 the substrate being a circular disc or cylinder, this
14 shape being determined by a number of factors, as
15 follows:

16

17 (a) Manufacture of the PDC's requires ultra high
18 pressures and temperatures, and a cylindrical vessel
19 provides the best solution for the containment of these
20 high pressures. Early PDC's had a diameter of 13 mm
21 (1/2 inch). However, much larger PDC's are now
22 produced. The substrate, which is a tungsten carbide
23 support material behind the polycrystalline diamond
24 layer, typically varies in thickness from 3 mm to 13
25 mm.

1 (b) The cylindrical shape of the PDC's facilitates
2 their attachment to the bit body, which is done in one
3 of two basic ways: either the PDC is brazed directly
4 into preformed circular holes in the bit body, or it is
5 high temperature brazed onto a cylindrical post or stud
6 (also of tungsten carbide) which in turn is press
7 fitted or brazed into preformed circular holes in the
8 bit body. In either case the circular configuration of
9 the PDC's simplifies the formation of the corresponding
10 holes in the bit body using conventional machine tools,
11 and in the latter case it similarly simplifies
12 manufacture of the posts.

13
14 There are, however, a number of disadvantages in using
15 cylindrical PDC's.

16
17 (i) The generation of the wear flat is not ideal as it
18 starts from a point contact which rapidly grows in the
19 form of a chord to the circular diameter diamond layer
20 on the face of the PDC cutter.

21
22 (ii) The weight on bit requirement to maintain
23 constant loading on the diamond layer rapidly increases
24 with the area of the wear flat.

25
26 (iii) The temperature of the cutter increases with the
27 development of the wear flat and the mud's ability to
28 cool the cutter drops.

29
30 (iv) The spacing between cutters is restricted by
31 their diameter and additionally, in the case of
32 post-mounted cutters, by the diameter of the post, its
33 depth of setting, and the curvature of the bit body
34 upon which it is set.

35

1 (v) In mounting cylindrical PDC's on a bit body there
2 is a trade off between the depth of setting and the
3 remaining cutter exposure; cylindrical cutters are
4 usually set at or below the waist, leaving only half or
5 less than half of the diameter exposed.

6
7 The objects of the present invention include obviating
8 or mitigating the abovementioned disadvantages of
9 existing PDC's and of drill bits incorporating such
10 PDC's.

11
12 According to a first aspect of the invention, there is
13 provided a polycrystalline diamond compact (PDC)
14 comprising a polycrystalline diamond layer affixed to a
15 substrate, said substrate being generally elliptical or
16 oval and having a major axis and a minor axis.

17
18 In the present disclosure the term "major axis" means
19 the axis along the largest edge-to-edge dimension of an
20 elliptical or oval body and "minor axis" means the axis
21 along the largest edge-to-edge dimension in a direction
22 at right angles to the major axis.

23
24 According to a second aspect, the invention provides a
25 post-mounted PDC, comprising an elliptical or oval PDC
26 as defined above, mounted on a post having a
27 corresponding cross-sectional shape.

28
29 According to a third aspect, the invention provides a
30 drill bit comprising a drill bit body having preformed
31 elliptical or oval holes formed therein and having a
32 plurality of elliptical or oval PDC's mounted in said
33 holes with the major axes of the PDC's extending
34 outwards from the surface of the bit body. The PDC's
35 may either be mounted directly in the holes or may be

1 post-mounted, the posts being mounted in the holes.

2

3 Preferably, the elliptical or oval PDC's are cut from a
4 circular PDC disc.

5

6 Preferably also, the bit body with said elliptical or
7 oval holes formed therein is produced by investment
8 casting. The elliptical or oval cross-section posts
9 for post-mounted PDC's may be produced in a similar
10 manner.

11

12 Embodiments of the invention will now be described, by
13 way of example only, with reference to the accompanying
14 drawings, in which:-

15

16 Fig. 1 is a schematic cross-sectional view of
17 part of a drill bit body showing a comparison
18 between the use of conventional, circular
19 PDC's and elliptical or oval PDC's in
20 accordance with the present invention;

21 Fig. 2 is an end elevation of a PDC in
22 accordance with the present invention;

23 Fig. 3 is a side view of a first PDC having an
24 end elevation as seen in Fig. 2;

25 Fig. 4 is a side view of a second,
26 post-mounted PDC also having an end elevation
27 as seen in Fig. 2;

28 Fig. 5 is a plan view of a PDC disc showing
29 the manner in which nested PDC's as seen in
30 Figs. 2, 3 and 4 may be cut from disc; and
31 Figs. 6, 7, 8 and 9 are views corresponding to
32 Figs. 2, 3, 4, and 5 for PDC's in accordance
33 with the invention having different dimensions
34 from the first and second PDC's.

35

1 Referring now to the drawings, Fig. 1 shows a sectional
2 view of part of a drill bit body 10, having a plurality
3 of PDC's 12 mounted around the periphery thereof in
4 correspondingly shaped holes or recesses. For purposes
5 of comparison, the drawing shows both conventional,
6 circular PDC's, 12a, and elliptical PDC's, 12b. As can
7 be seen, the minor axes of the elliptical PDC's 12(b)
8 are equal in length to the diameters of the circular
9 PDC's 12(a) and the major axes of the elliptical PDC's
10 12b extend outwardly from the surface of the bit body
11 10.

12
13 The use of elliptical or oval PDC's in accordance with
14 the invention provides the following advantages in
15 comparison with equivalent circular PDC's:

16
17 (a) The rate at which the area of the wear flat
18 develops as the PDC is worn away can be considerably
19 reduced in comparison with circular PDC's.

20
21 (b) The weight on bit required to maintain constant
22 loading on the diamond layer does not have to be
23 increased so significantly due to the slower
24 development of the wear flat.

25
26 (c) The area of the PDC's exposed to the cooling
27 effects of drilling mud is increased in comparison with
28 circular PDC's.

29
30 (d) A greater overall cutting surface is available in
31 comparison with circular PDC's owing to closer spacing
32 of PDC's and/or the greater exposed areas of individual
33 PDC's.

34
35 Fig. 2 shows an end elevation of an elliptical PDC 14

1 in accordance with the invention, having a major axis
2 dimension of 13.44 mm and a minor axis dimension of
3 11.318 mm, i.e. an aspect ratio of approximately 1.2.
4 Fig. 3 shows a side view of a first PDC 16 comprising a
5 polycrystalline diamond layer 18 (0.5 mm in thickness)
6 on a tungsten carbide substrate 20, (giving an overall
7 thickness of 8 mm), and having a cross-sectional shape
8 as seen in Fig. 2. Fig. 4 shows a post-mounted PDC 22
9 comprising a diamond layer 24 on a substrate 26 (giving
10 an overall thickness of 3 mm), located on a tungsten
11 carbide post 2 (resulting in an overall length of
12 20 mm) and again having the cross-sectional shape seen
13 in Fig. 2.

14
15 Fig. 5 shows the manner in which a plurality of PDC's
16 of this shape may be cut from a 2 inch PDC disc 30. 11
17 such cutters can be obtained from a 2 inch diameter
18 disc, utilising 64.8% of the total disc area, as
19 compared with 9 circular 13.4 mm diameter PDC's which
20 could be obtained, utilising 62.99% of the disc area.

21
22 Figs. 6 to 9 are equivalent illustrations for a
23 19.05 mm by 13.44 mm PDC 32 (having an aspect ratio of
24 approximately 1:4), Fig. 7 showing a PDC 34 having a
25 diamond layer 36 and substrate 38, Fig. 8 a
26 post-mounted PDC 40 having a diamond layer 42,
27 substrate 44 and post 46, and Fig. 9 showing the
28 nesting of such PDC's on a 2 inch PDC disc 48. In this
29 case, 5 PDC's are obtained from the disc, utilising
30 59.53% of its area in comparison with 4 circular, 19 mm
31 diameter PDC's which could be obtained, utilising
32 56.25% of the area.

33
34 Referring back to Figs. 2 and 3, the edge of the
35 polycrystalline diamond layer 18 may be chamfered or

1 radiused along at least a part of its periphery
2 adjacent that end of the major axis which projects
3 outwardly from the bit body in use, preferably along a
4 chord determined by the chamfer angle and diamond layer
5 thickness as indicated by lines 50 and 52. This
6 reduces the possibility of the PDC fracturing upon
7 first use.

8
9 The production of bit bodies with elliptical or oval
10 cutter recesses is advantageously accomplished using
11 investment casting techniques such as are disclosed in
12 WO90/01384. However, conventional steel and matrix
13 techniques might also be employed. The elliptical or
14 oval PDC's themselves can be cut from large circular
15 PDC discs using EDM wire cutting techniques, and with
16 efficient nesting might be produced at slightly lower
17 cost than equivalent circular PDC's.

18
19 Modifications and improvements may be incorporated
20 without departing from the scope of the invention.

21

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31 CHARTERED PATENT AGENTS
32 MITCHELL HOUSE
33 333 BATH STREET
34 GLASGOW
35 G2 4ER

1 CLAIMS

2

3 1. A polycrystalline diamond compact (PDC) comprising
4 a polycrystalline diamond layer affixed to a substrate,
5 said substrate being generally elliptical or oval and
6 having a major axis and a minor axis, wherein the term
7 "major axis" means the axis along the largest
8 edge-to-edge dimension of an elliptical or oval body
9 and "minor axis" means the axis along the largest
10 edge-to-edge dimension in a direction perpendicular to
11 the major axis.

12

13 2. A PDC as claimed in Claim 1, wherein the ratio of
14 the length of said major axis to said minor axis is in
15 the range 1.2 to 1.4.

16

17 3. A PDC as claimed in Claim 1, wherein at least a
18 portion of the edge of said polycrystalline diamond
19 layer adjacent one end of said major axis is chamfered
20 or radiused.

21

22 4. A method of forming PDC's as claimed in any of
23 Claims 1 to 3, wherein a plurality of said oval or
24 elliptical PDC's are cut from a circular PDC disc.

25

26 5. A post-mounted PDC, comprising an elliptical or
27 oval PDC as claimed in any of Claims 1 to 3, mounted on
28 a post having a corresponding cross-sectional shape.

29

30 6. A drill bit comprising a drill bit body having
31 preformed elliptical or oval holes formed therein and
32 having a plurality of PDC's as claimed in any of Claims
33 1 to 3 or 5 mounted in said holes with the major axes
34 of the PDC's extending outwards from the surface of the
35 bit body.

1 7. A drill bit as claimed in Claim 6, wherein said
2 PDC's are mounted directly in said holes.

3
4 8. A drill bit as claimed in Claim 6, wherein said
5 PDC's are post-mounted and said posts are mounted in
6 said holes.

7
8 9. A method of forming a post-mounted PDC as claimed
9 in Claim 5, wherein said post is formed by investment
10 casting.

11
12 10. A method of forming a drill bit as claimed in
13 Claim 6, wherein said bit body is formed by investment
14 casting.

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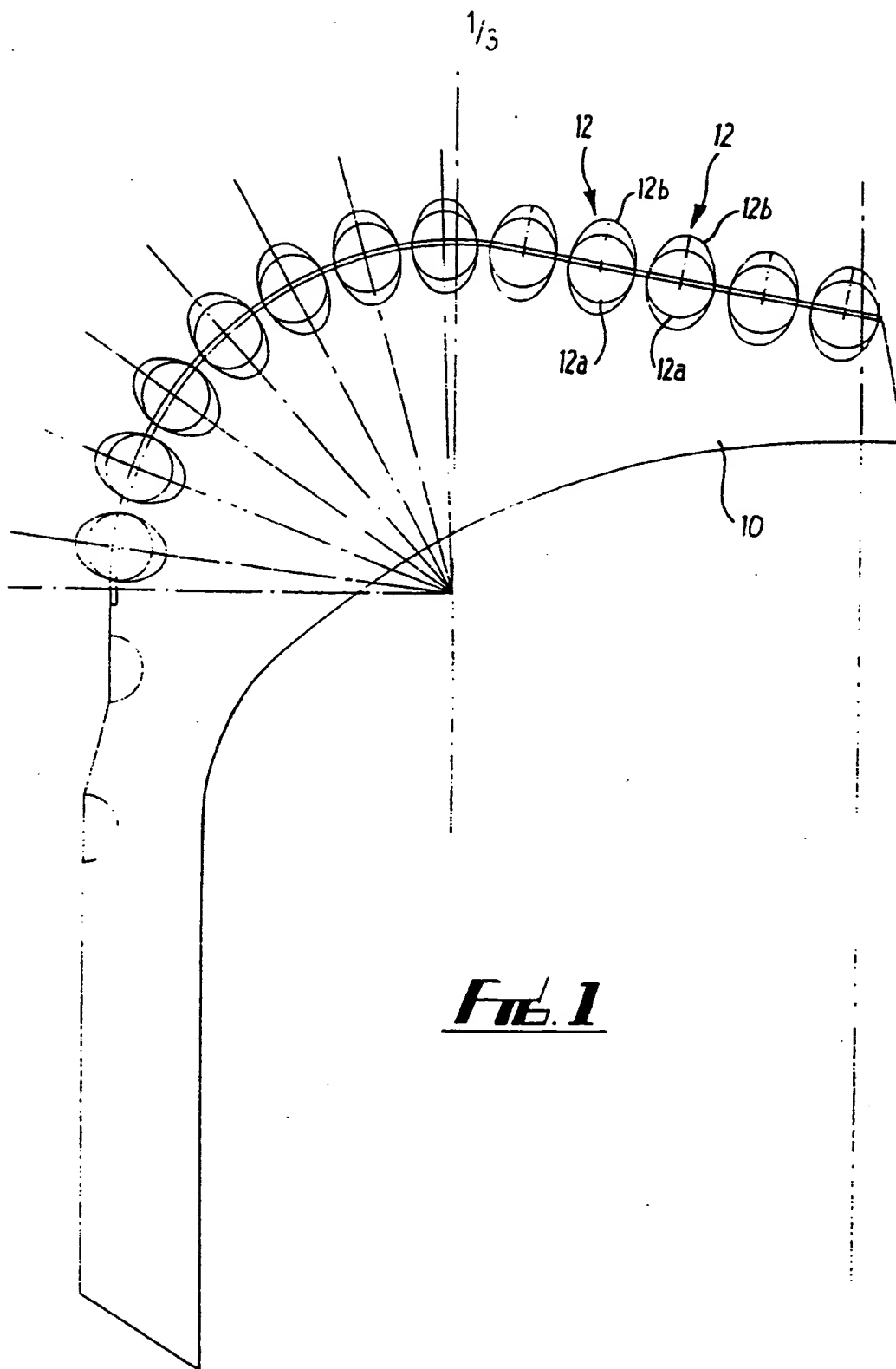
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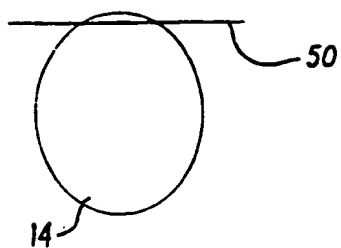
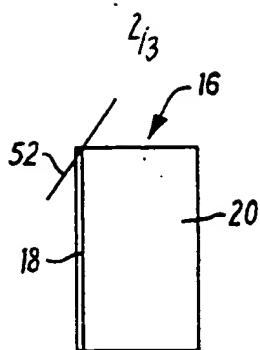
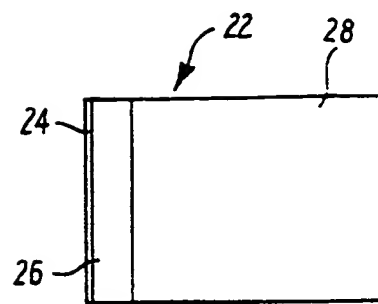
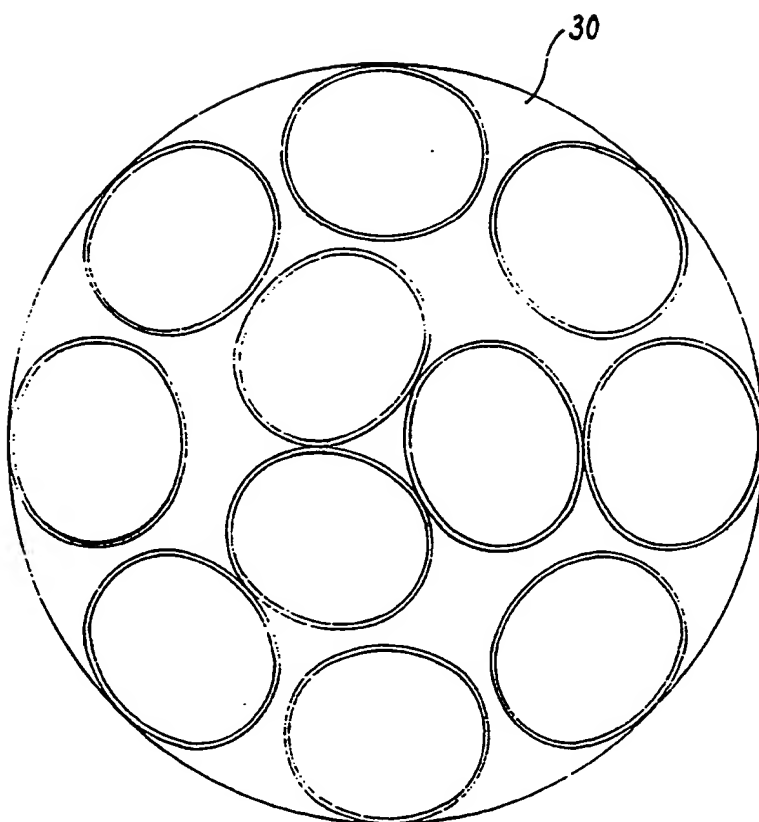
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**SUBSTITUTE SHEET**

**FIG. 2****FIG. 3****FIG. 4****FIG. 5**

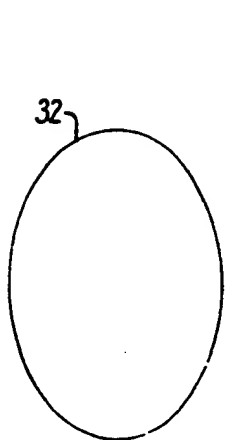


FIG. 6

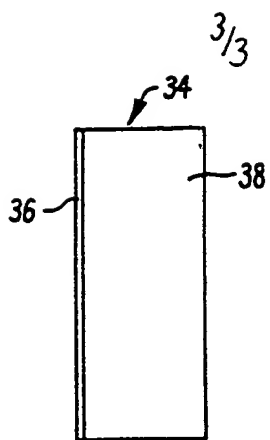


FIG. 7

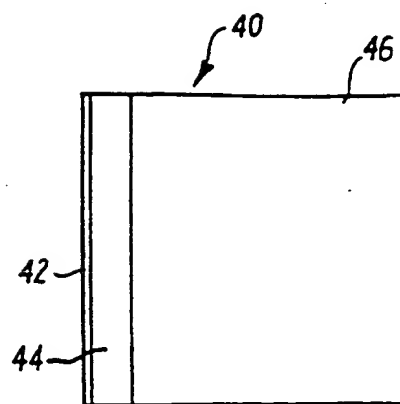


FIG. 8

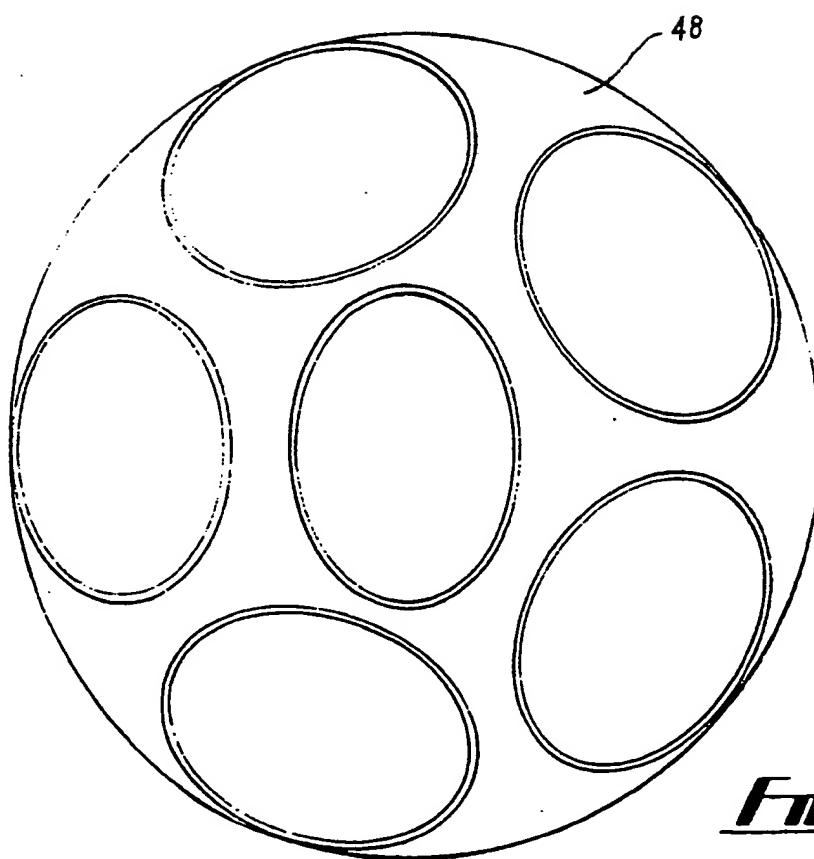


FIG. 9

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 92/00321

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.C1. 5 E21B10/56		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.C1. 5	E21B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	EP,A,0 188 360 (NL PETROLEUM PROD. LTD) 23 July 1986	1
Y	see page 4, line 14 - page 7, line 17; figures 5,6	3,4
A	see page 9, line 4 - line 13	5,6
	see page 12, line 20 - page 13, line 16	
Y	US,A,4 632 196 (DENNIS) 30 December 1986	3
	see column 5, line 28 - line 30	
Y	EP,A,0 117 241 (STRATA BIT CORP.) 29 August 1984	4
	see page 3, line 5 - line 20; figures 5-7	
	see page 7, line 11 - line 36	
	--- -/-	
<p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
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04 JUNE 1992	12.06.92	
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	EP,A,0 154 936 (NORTON CHRISTENSEN) 18 September 1985 see page 21, line 23 - page 22, line 12; figures 6,7	1
A	EP,A,0 156 235 (NORTON CHRISTENSEN) 2 October 1985 see abstract; figures 4,7	1
A	WO,A,9 001 384 (ASTEC DEVELOPMENTS) 22 February 1990 cited in the application see abstract	9,10

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. GB 9200321
SA 56684**

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0188360	23-07-86	US-A- 4705122	10-11-87
US-A-4632196	30-12-86	None	
EP-A-0117241	29-08-84	US-A- 4724913 CA-A- 1214159 JP-A- 59161587	16-02-88 18-11-86 12-09-84
EP-A-0154936	18-09-85	CA-A- 1248939 JP-A- 60212588	17-01-89 24-10-85
EP-A-0156235	02-10-85	AU-A- 4021785 CA-A- 1245625 JP-A- 60223594	03-10-85 29-11-88 08-11-85
WO-A-9001384	22-02-90	AU-A- 4060389 EP-A- 0430989	05-03-90 12-06-91